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ABSTRACT

Fluctuations in problem solving and classroom behaviors during the school day for 43 hyperkinetic intermediate students with attention deficits were examined. Ss were observed with the Stonybrook Observation Code and tested with the Stroop Color-Word Test, Matching Familiar Figures, Porteus Mazes, and Digit Span. Data were collected in counterbalanced morning and afternoon sessons. Analysis of results revealed that Ss performed better in the morning on problem solving tasks except Digit Span. In classroom behavior, all Ss exhibited more interference, off task behavior noncompliance, and minor motor movement in the afternoon. (Author/CL)

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Time of Day and Its Effect on Pupil Problem Solving and Classroom Behavior[1]

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Abstract

This study describes fluctuations in problem solving and classroom behaviors during the school day for nonmedicated pupils who had attention deficits with hyperkinesis. The forty-three participating pupils were observed with Stonybrook Observatior Code, and tested with Stroop Color-Word Test, Matching Familiar Figures, Porteus Mazes, and Digit Span. Test data were collected in counterbalanced morning and afternoon sessions. Twenty-one pupils were administered the tests in the morning and the afternoon; the remainder were tested in the afternoon and the following morning. Equivalent test forms were used. Direct observations were completed for four minutes in the morning and for four minutes in the afternoon once each week over a four week period. Repeated measures multivariate ANOVAs were followed by univariate and correlational analyses. On problem solving task except Digit Span, pupils performed better in the morning. In classroom behavior, all pupils exhibited more interference, off-task, noncompliance, and minor motor movement in the afternoon. The results are discussed in terms of scheduling problem solving tasks in the morning and less structured activities in the afternoon.

The Effect of Time of Day on Problem Solving and Classroom Behavior

This study was undertaken to describe fluctuations of problem solving and classroom behavior during the school day (morning and afternoon) for a sample of pupils who had attention-deficits with hyperkinesis and to relate these fluctuations to teaching and classroom organizational variables. Performance fluctuations have not been studied for pupils with special characteristics. The assumption has been that pupils with special characteristics are different from pupils with no diagnosed learning difficulties. Previous studies have shown that normal children and adults have fluctuations of problem solving during the day that are independent of fatigue and boredom (Mackenberg et al, 1974; Colquhoun, 1971; Johnson et al, 1981).

Of all the childhood disorders, attention-deficits with hyperkinesis has generated the greatest amount of interest and controversy (Whalen and Henker, 1980). Estimates of prevalence range from 1 to 20% for all school-age children (Renshaw, 1974). The definition and diagnosis of attention-deficits with hyperkinesis includes a constellation of symptoms extending along various behavioral, perceptual-cognitive and social-environmental dimensions. The primary symptoms consist of excessive activity, short attention span, poor scholastic performance despite normal intelligence, impulsivity, excitability, and distractibility (DSM-III). In addition several secondary signs are often present such as aggressiveness, low frustration and poor self-esteem (Clements, 1966; Whalen and Henker, 1976).

Two approaches to defining attention-deficits with hyperkinesis in children are educational performance and activity-arousal models. The educational models describe problems in efficient task strategies.

Torgensen (1977) suggests that learning failure in these children does not necessarily indicate a specific psychological process deficit in attention, short-term memory or perception. Rather, performance decrements are viewed in different task settings as due to the child's failure to engage in the task through efficient strategies in learning (Flavell, 1971). The poor performance of these children is interpreted as a lack of cognitive and emotional characteristics necessary to adapt to task requirements. Kagan (1966) calls this an impulsive, as opposed to reflective, cognitive style.

The second approach postulates differences in psychophysiological processes and incorporates more global concepts of arousal (Whalen and Henker, 1980). Two opposing explanations of arousal processes have been advanced. The syndrome is attributed to hyperarousal, that is a reaction to excessive sensory stimulation with concommitant inability to filter and organize stimulus overload (Strauss and Lehtinen, 1947; Firestone and Douglas, 1959; Lauffer et al, 1957; Douglas, 1972; Douglas and Peters, 1980). The alternative explanation is hypoarousal or stimulus-seeking behavior which emanates from increased motor activity (Zentall, 1977). This view is based on the premise that homeostatic mechanisms function to maintain a level of stimulation within some optimal range (Hebb, 1955).

Method

Subjects

The forty-three nonmedicated subjects for this study were pupils enrolled in four different intermediate level classrooms. The teachers were trained in behavior disorders, learning disabilities and emotional problems. Pupils were defined as having attention-deficits with hyperkinesis by medical

examinations, psychological tests, teacher plus parent ratings, and DSM-III criteria of inattention, impulsivity and hyperactivity associated with features of low frustration tolerance, lack of response to discipline, temper outbursts and academic underachievement. Descriptive psychological testing used to define this population included the WISC-R (lower limit of IQ = 80), the WRAT, the Beery Visual-Motor Test, the Bender Visual-Motor Gestalt Test, the Peabody Picture Vocabulary Test and the Stonybrook Teacher Rating Scale (Abikoff, Gittleman-Klein, and Klein, 1977; O'Leary and Stern, 1982). Twelve girls and 31 boys with a mean age of 10 years, 4 months (S.D.= 9 months) were administered a series of four tests and were observed using the Stonybrook Observation Code (Abikoff, Gittleman-Klein, and Klein, 1977; 1980).

Instruments

The tests included the Stroop Color-Word Test, the Matching Familiar Figures Test, the Porteus Mazes and the Digit Span Test (Stroop, 1935; Kagan, 1966; Porteus, 1950; Wechsler, 1974). Test data were collected in "counter-balanced" morning and afternoon sessions. Twenty-one pupils were administered the tests in the morning and the afternoon; the remainder were tested in the afternoon and the following morning. The class sizes were 9, 11, 11 and 12 pupils.

The observational scale used was the Stonybrook Observation Code, which resulted in scores of twelve operationally defined classroom behaviors: (a) interference, (b) off-task behavior, (c) noncompliance, (d) minor motor movement, (e) gross motor movement, (f) out-of-chair, (g) physical aggression, (h) aggressive threats to other children, (i) aggressive threats to the teacher, (j) vigorous gross motor movement, (k) solicitation, and (l) on-task behavior. The direct observations were completed for four minutes in the morning and for four minutes in the afternoon once each week over a four week period. The observations were recorded in 15 second time intervals.

All observations were completed using a randomized schedule. The coefficients of agreement for the two trained observers ranged from .70 to .99 for the various observational scales. Observations and testing occurred during regularly scheduled instructional activities of reading, writing, arithmetic and spelling.

Problem solving and behavior rating instruments had high test-retest reliability and large standardization samples. Problem solving tasks assessing cognitive performance were short and easy to administer. The rationale for selecting these instruments was to converge on the entity of attention-deficits with hyperkinesis and to diverge in method of measurement (Homatidis and Kostantareas, 1981).

The statistical analyses included multivariate repeated measures ANOVAs for the psychometric and the observational data. The repeated measures included performance on the dependent variables for time of day (morning and afternoon); the blocking variables were order of presentation and sex. Following the multivariate analyses, univariate analyses were considered as an aid to interpretation for any significant ($p < .01$) variables. The assumptions of ANOVA, normality and homogeneity of variance, were met for the dependent variables including problem solving tasks and classroom behavior (Bock, 1971). Pearson correlations of the problem solving tasks with the classroom behaviors were performed on both the morning and afternoon data.

Results

The multivariate analyses of cognitive tasks revealed significant differences by time of day. The pupils performed significantly better in the morning than in the afternoon on all problem solving tasks except Digit Span. Time of day was the only blocking variable that was significantly different.

When the univariate analyses of variance were considered, all of the psychometric measures showed significant differences except for Digit Span. See Tables 1 and 2.

Insert Tables 1 and 2 about here

In classroom behavior these pupils exhibited more interference, off-task behavior, noncompliance, and minor motor movements in the afternoon. The multivariate analyses with repeated measures for the behavior codes by time of day, by day of observation, and by sex resulted in rejection of the null hypothesis for the time of day by day of observation interaction. The univariate analyses gave some clues to those variables which contributed to this significant difference: interference, noncompliance, minor motor movement, gross motor movement, out-of-chair, and on-task behavior. Univariate analyses of behavior ratings indicated time of day differences for minor motor movement. There were more minor motor movements in the afternoon. Sex differences for interference and aggressive threats to children were found by univariate analyses. For interference boys were higher than girls; for aggressive threats to chilren, girls exceeded boys. There was also a significant day differences for aggressive threats to other children. See Tables 1 and 2.

Insert Table 3 about here

The Pearson product-moment correlations between the cognitive tasks and the behavior ratings in the morning were computed. Only 23 of the eighty correlations were significant. The correlations for the afternoon periods on the cognitive tasks and behavior ratings are also presented in

in Table 3. Thirteen of the 96 correlations were significant. The number of zero entries in several behavior categories limits the use of the Pearson correlations. Only six behavior categories consistently revealed significant correlations in both the morning and afternoon. These results suggest that larger samples of low base rate behavior need to be collected in order to obtain stable coefficients of higher magnitude than those obtained (Cobb, 1972).

Discussion

Fluctuations of problem solving and classroom behaviors during the school day were substantiated for pupils who have attention-deficits with hyperkinesis. This finding parallels other studies of fluctuations of problem solving over the day-night cycle found in normal children and adult populations that are not attributable to fatigue or to boredom . The lack of sex differences in problem solving performance confirmed earlier reports (Maccoby and Jacklin, 1975). Practice effects for multiple presentations of the Stroop Color-Word Test were also found. This study also confirms reports that problem solving and classroom behaviors are interrelated.

The practical implications of this study are that teachers can take advantage of these fluctuations in problem solving performance and behavior at different times of the day. Educational facilities may be used more effectively by scheduling classes to changes in pupils performance over the day. Overlearned, repetitive tasks and difficult problem solving should be scheduled in the morning, while recreational or physical education classes can fill the time period after lunch in the afternoon. Another alternative would be to have a longer lunch break and extend classes into the later afternoon in order to provide more efficient learning time. By proper timing of the teaching sessions to the individual's fluctuations rather than to the clock hour,

the child with attention-deficits and hyperkinesis may be able to absorb more effectively with less effort and less expense.

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Table 1

Means and Standard Deviations of Problem Solving Tasks and Classroom Behavior Ratings

Problem Solving Task	Order of Presentation	Time of Day: Morning Mean	Morning SD	Afternoon Mean	Afternoon SD
Porteus Maze Errors					
Boys	Morning-afternoon	6.6	(3.2)	10.5	(5.3)
	Afternoon-morning	6.1	(2.4)	7.1	(1.9)
Girls	Morning-afternoon	6.3	(2.4)	9.7	(4.7)
	Afternoon-morning	7.8	(3.3)	8.7	(2.3)
Porteus Maze Score					
Boys	Morning-afternoon	74.4	(21.6)	90.4	(15.4)
	Afternoon-morning	66.1	(13.9)	68.0	(25.9)
Girls	Morning-afternoon	70.7	(11.6)	83.8	(19.9)
	Afternoon-morning	65.8	(17.7)	78.0	(14.3)
Digit Span					
Boys	Morning-afternoon	10.8	(3.6)	10.2	(3.1)
	Afternoon-morning	9.3	(4.3)	9.3	(3.1)
Girls	Morning-afternoon	9.8	(3.4)	9.3	(1.9)
	Afternoon-morning	9.5	(4.3)	8.3	(3.4)
MFFT Errors					
Boys	Morning-afternoon	11.0	(5.5)	12.4	(4.0)
	Afternoon-morning	10.1	(5.0)	11.4	(4.7)
Girls	Morning-afternoon	9.3	(4.9)	10.5	(5.9)
	Afternoon-morning	10.8	(1.6)	15.3	(4.7)
MFFT Response Time					
Boys	Morning-afternoon	79.4	(27.5)	91.7	(29.1)
	Afternoon-morning	93.2	(31.7)	117.1	(39.5)
Girls	Morning-afternoon	117.3	(20.6)	138.9	(42.6)
	Afternoon-morning	81.2	(43.4)	96.5	(33.0)
Stroop Word Naming					
Boys	Morning-afternoon	76.3	(19.2)	62.8	(16.7)
	Afternoon-morning	61.1	(16.0)	55.4	(15.8)
Girls	Morning-afternoon	64.3	(21.7)	46.2	(15.9)
	Afternoon-morning	66.8	(17.9)	57.8	(16.9)
Stroop Color Naming					
Boys	Morning-afternoon	61.1	(19.9)	49.1	(13.7)
	Afternoon-morning	55.0	(11.4)	47.5	(11.7)
Girls	Morning-afternoon	55.0	(18.8)	35.2	(9.3)
	Afternoon-morning	55.8	(12.9)	46.5	(11.0)
Stroop Interference					
Boys	Morning-afternoon	43.4	(21.4)	33.7	(12.2)
	Afternoon-morning	46.1	(12.9)	37.6	(13.7)
Girls	Morning-afternoon	38.5	(18.2)	24.0	(8.7)
	Afternoon-morning	41.7	(8.5)	33.2	(15.3)

Classroom Behavior	Time of Day: Morning Mean	Morning SD	Afternoon Mean	Afternoon SD
Interference				
Boys	3.8	(3.2)	6.0	(4.7)
Girls	1.1	(1.8)	3.4	(3.0)
Off-Task				
Boys	5.0	(4.3)	10.2	(7.4)
Girls	5.9	(4.3)	11.0	(6.3)
Noncompliance				
Boys	0.2	(0.5)	0.5	(1.7)
Girls	0.0	(0.0)	0.5	(1.7)
Minor Motor Movement				
Boys	5.0	(4.3)	7.6	(4.3)
Girls	3.2	(5.0)	8.8	(4.0)
Gross Motor Movement				
Boys	2.4	(2.7)	1.1	(1.7)
Girls	4.9	(5.0)	4.0	(4.8)
Out-of-Chair				
Boys	2.4	(2.7)	1.0	(1.8)
Girls	4.8	(5.0)	4.0	(4.9)
Physical Aggression				
Boys	0.0	(0.0)	0.0	(0.0)
Girls	0.2	(0.6)	0.0	(0.0)
Aggressive Threats to Children				
Boys	0.2	(0.6)	0.0	(0.0)
Girls	0.4	(1.0)	0.0	(0.0)
Aggressive Threats to Teacher				
Boys	0.0	(0.0)	0.0	(0.0)
Girls	0.1	(0.2)	0.0	(0.0)
Vigorous Gross Motor Movement				
Boys	0.4	(1.8)	0.0	(0.0)
Girls	0.1	(0.6)	0.1	(0.3)
Solicitation				
Boys	0.9	(1.6)	1.3	(2.1)
Girls	2.0	(2.8)	2.7	(3.4)
On-Task				
Boys	14.5	(4.2)	7.9	(4.8)
Girls	12.3	(5.1)	7.6	(4.3)

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Table 2

Summary Table of Repeated Measures ANOVAs for Problem Solving Tasks and Classroom Behavior

	Between			Within				
	Sex	Order	Sex-Order	Time	Order-Time	Sex-Time	Sex-Time-Order	Error
ivariate ANOVAs(F)								
Porteus Mazes Errors	0.16	1.75	0.96	37.53**	11.54**	0.39	0.04	
Porteus Mazes Score	0.01	3.21	0.41	8.06**	1.98	0.14	0.63	
Digit Span	0.56	0.66	0.01	2.39	0.07	0.05	0.99	
MFFT Errors	0.02	0.03	2.0?	8.32**	0.42	1.45	1.50	
MFFT Response Time	1.83	0.11	7.98**	11.52**	0.38	0.01	0.57	
Stroop Word Naming	1.00	1.47	2.66	47.77**	6.58**	1.02	0.36	
Stroop Color Naming	1.40	0.07	1.26	31.75**	2.38	1.07	0.45	
STroop Interference	1.58	1.04	0.09	27.00**	0.43	0.33	0.34	
grees of Freedom	1	1	1	1	1	1	1	35
ltivariate ANOVAs(F)	0.34	1.15	1.74	13.98**	2.38**	0.58	0.61	
grees of Freedom	8	8	8	8	8	8	8	

	Between			Within				
	Sex	Day	Sex-Day	Time	Sex-Time	Time-Day	Sex-Time-Day	Error
ivariate ANOVAs(F)								
Interference	3.98*	0.39	2.72	0.09	0.03	7.44**	0.67	
Off-Task	1.23	0.90	2.97	0.76	1.40	18.35**	0.13	
Noncompliance	0.39	3.50*	1.19	0.28	1.88	3.70**	1.05	
Minor Motor Movement	0.53	2.69	1.61	4.77*	0.57	11.66**	0.86	
Gross Motor Movement	0.01	1.37	1.20	0.34	0.08	13.58**	0.91	
Out-of-Chair	0.04	1.43	1.83	0.58	0.58	11.77**	0.72	
Physical Aggression	0.30	0.26	1.60	0.04	3.36	1.17	0.70	
Threats to Children	4.70*	5.89*	2.55	1.27	0.55	0.54	0.23	
Threats to Teacher	1.32	1.21	0.52	0.70	0.30	0.52	0.23	
Vigorous Motor Moves	0.26	0.69	2.58	1.36	3.14	1.32	2.28	
Solicitation	0.03	0.61	0.31	0.26	1.30	2.31	0.40	
On-Task	0.49	0.53	2.64	3.36	0.02	39.55**	0.71	
grees of Freedom	1	2	2	1	1	2	2	31
ltivariate ANOVAs(F)	1.70	1.44	1.00	0.83	0.88	4.89**	1.34	
grees of Freedom	12	24	24	12	12	24	24	

**p < .01 *p < .05

Table 3

Product Moment Correlations of Problem Solving Tasks and Classroom Behaviors: Morning (Afternoon)

Problem Solving Tasks \ Behaviors	Interference	Off-Task	Noncompliance	Minor Motor Movement	Gross Motor Movement Standing	Out-of-Chair	Aggression	Aggressive Threats to Children	Aggressive Threats to Teacher	Gross Motor Movement Vigorous	Solicitation	On-Task
Porteus Mazes Errors				-.30*								
	(.30*)		(.28*)	(-.33*)	(.36**)	(.34*)				(-.27*)		
Porteus Mazes Score			.32*									
	(.38*)		(.31*)	(.26*)	(.38*)	(.42**)						
Digit Span		-.33*			-.39**	-.40**					-.43**	.26*
MFFT Errors										.34*	.32*	
Stroop Word Naming		-.34*			-.2*	-.29*					-.32*	.27*
									(.31*)			
Stroop Color Naming		-.42**			-.40**	-.41**					-.32*	.35*
									(.36*)			
Stroop Interference					-.31*	-.32*					-.32*	.26*
						(-.27*)						

**p < .01 *p < .05 morning (afternoon)